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Weapon System Sustainment Value Stream Model

September 06, 2006

Overview



- **The objectives**
- **The architecture: 3 modules under a WSSVSM manager**
- **The capability demonstration**



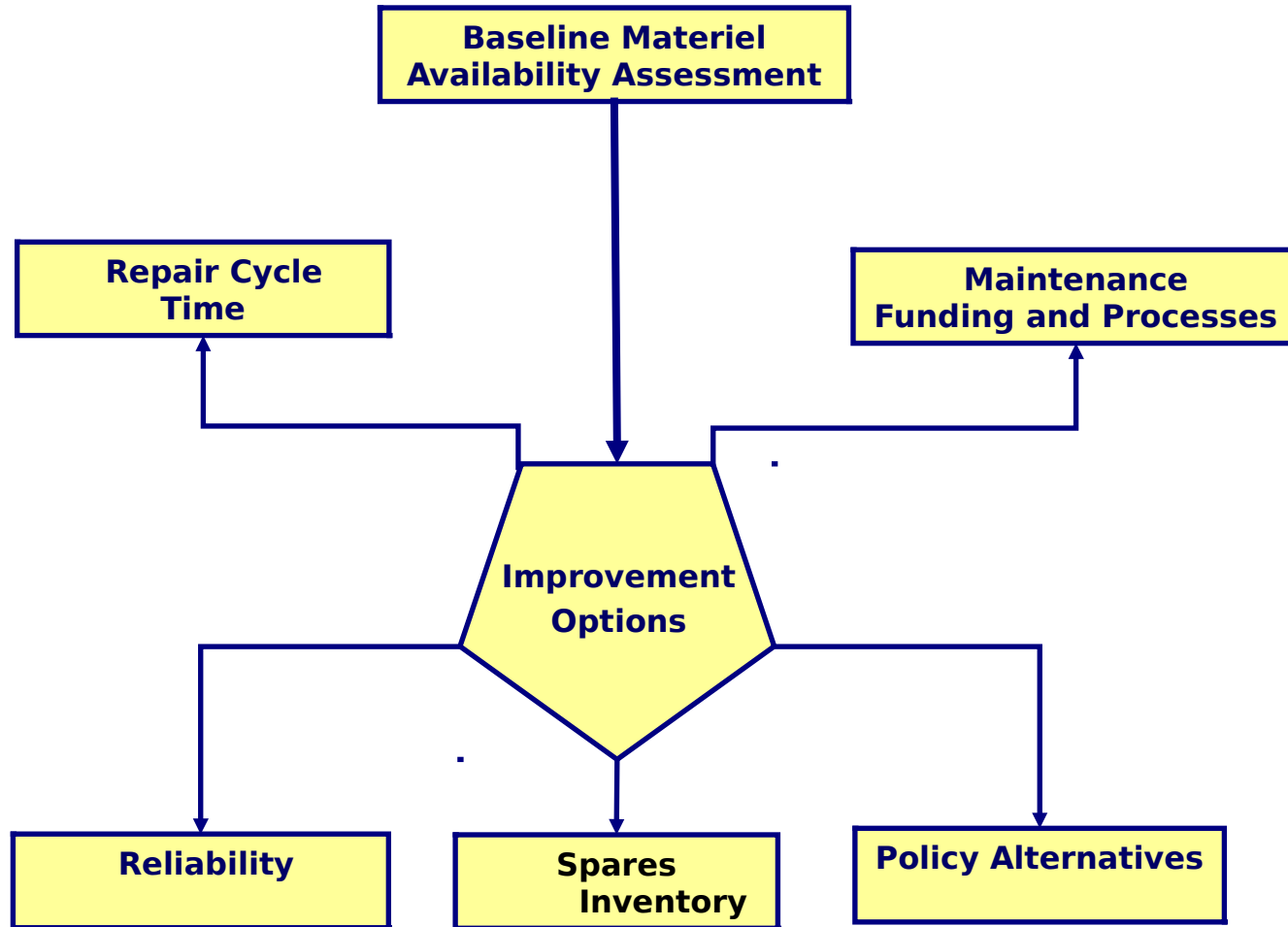
The Objectives



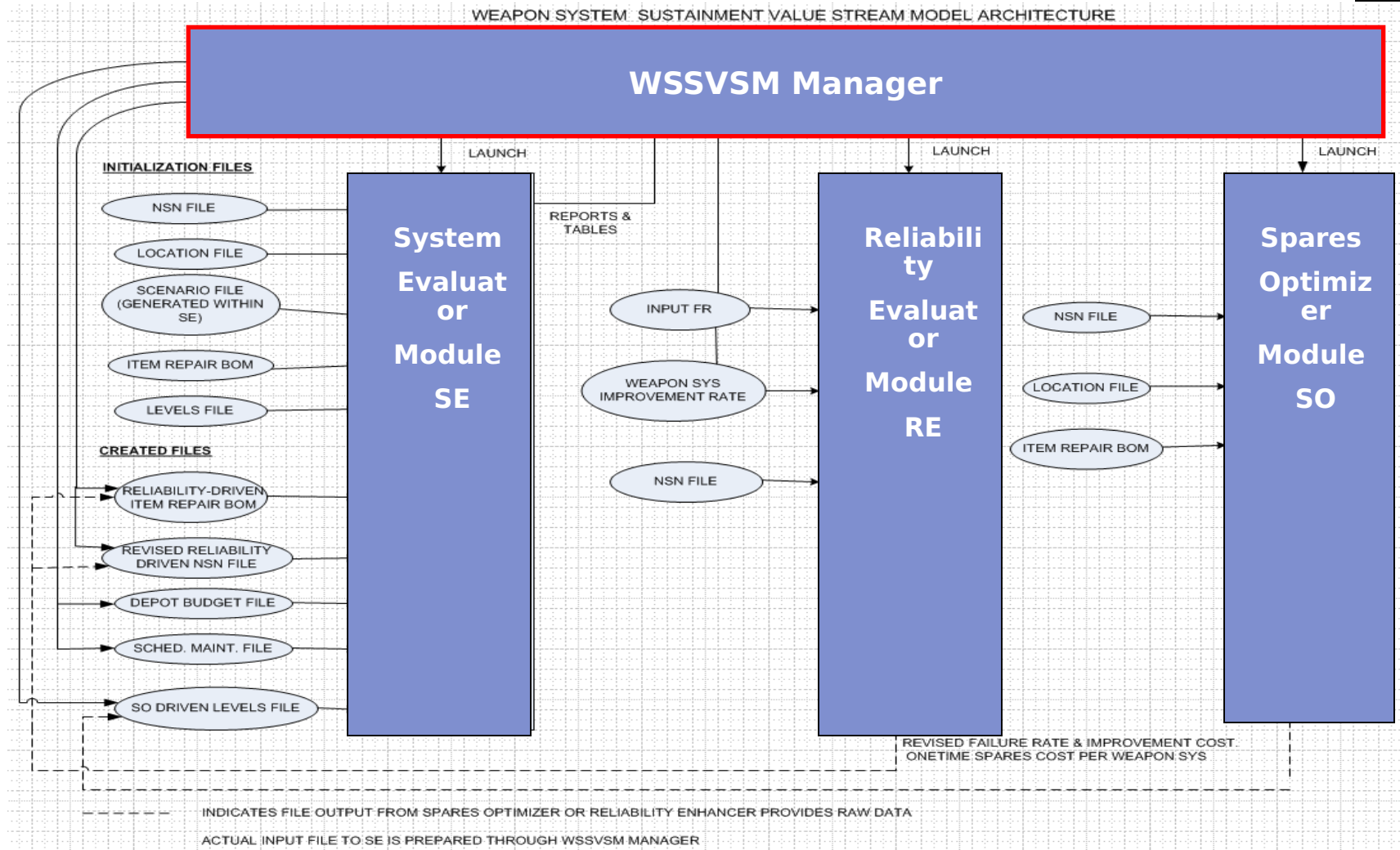
- **Quantify weapon system availability implications:**
 - Improved reliability
 - Improved repair cycle times
 - Unfunded depot maintenance
 - Optimized repair parts inventory
 - Enhanced policies that improve cycle time



Target Outcome: Improve WSSVS Processes and Characteristics to Achieve Weapon System Availability Goals



The Architecture: 3 Modules Under the WSSVSM Manager

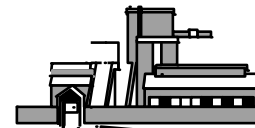
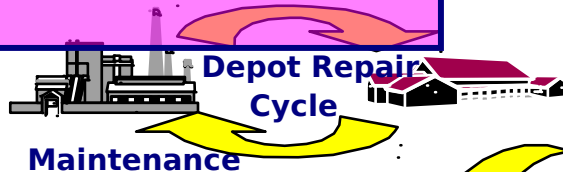


SYSTEM EVALUATOR (SE)



**DoD Materiel availability
Policies,
Practices and Procedures
Are Applied...**

**Depot
Operations**



**Procurement
Pipeline**



**In a Multi Echelon,
Multi Indentured**



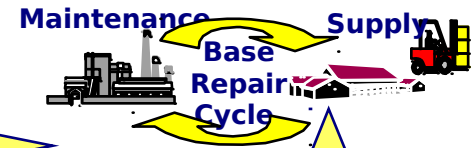
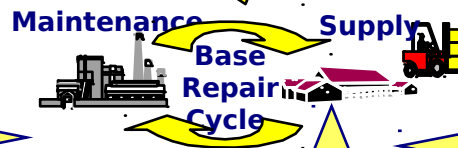
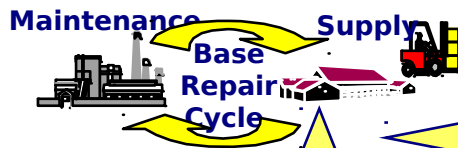
Environment

and Evaluated ...

**Field
Operating
Locations**

**Order & Ship
Pipeline**

**Retrograde
Pipeline**



Lateral Supply

Lateral Supply



in Terms of Weapon System Availability

System Evaluator Enhancements



- **View and compare metrics from alternative scenarios**
- **Developed**
 - Availability implications of all unfunded scheduled depot maintenance
 - Capability to emulate the Army and Navy process for setting wholesale parts inventory levels
 - Part delays of critical items for the Reliability Evaluator (RE)
 - Data input and output interfaces to the Spares Optimizer and Reliability Evaluator



Reliability Evaluator (RE)



- **Develops a fault tree of the weapon system based on part failure rates**
- **For specified parts**
 - Minimizes the fixed costs of achieving a specified reliability or weapon system availability
 - Maximizes the reliability or availability that can be achieved for a specified fixed cost



Reliability Evaluator Enhancements



Developed WSSVSM Utility to

- Automatically accept data input from the System Evaluator,
- Develop standard input files for the SyOp
- Export data to the System Evaluator

Further developed

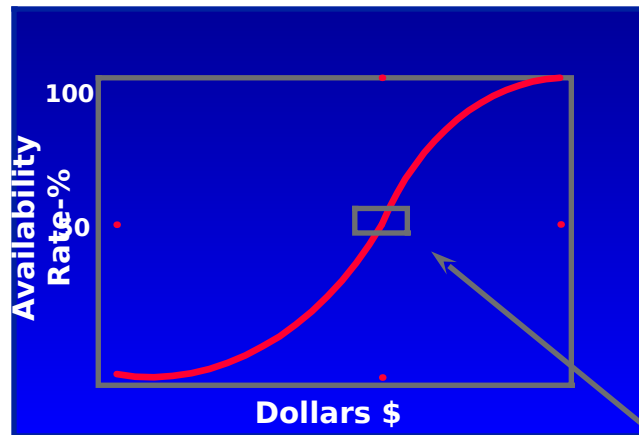
- Seven cost categories for parts and automated the input of cost data for each part in that category by specifying the fixed and marginal cost of reliability improvement
- Rolled up delta costs of children (subordinate parts) to cost of parent (higher indenture parts)



Spares Optimizer (SO)



- Minimize the spares cost of achieving an availability objective in a multi-indentured, multi-echelon environment



Shopping List

Item (A,B,C...)	Unit cost \$	Added end items per \$10K	Total cost \$	Availability rate %
6th A	1,600	0.388	101,600	66.67
11th B	2,300	0.352	103,900	66.69
2nd C	10,400	0.312	114,300	66.74
12th B	2,300	0.283	116,600	66.76
1st D	13,800	0.154	130,400	66.78
7th A	1,600	0.144	132,000	66.79

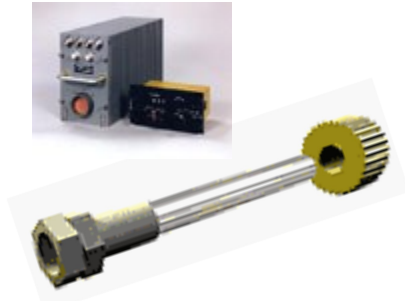




- **Integration**
 - Conducts file management
 - Prepares data for underlying modules
 - Permits viewing and comparing alternative results
- **Additional functionality not found in underlying modules**
 - Assesses availability implications of unfunded scheduled depot maintenance of aviation systems
 - Provides a capability to determine the availability implications of unfunded depot maintenance of ground systems that feed the System Evaluator



WSSVSM Inputs - Overview



NSN Data

- ~20 data elements
- Descriptive
- Configuration
- Repair/maintenance/reliability characteristics
- Piece/parts requirements for repair actions



Location Data

- ~15 data elements
- Operating units (i.e., value stream nodes)
- Weapon system assignments (if applicable)
- Distances/movement times
- Specific weapon system availability goals (when applicable)



Scenario Data

- Simulation control variables (e.g.)
 - ✓ Start up time
 - ✓ Run time
 - ✓ Random seed
- Support options and analysis capabilities such as:
 - ✓ Expedited shipments
 - ✓ Lateral support
 - ✓ Cannibalization
 - ✓ Maintenance Scheduling
 - ✓ Requisition priorities



The Capability Demonstration



- **F-15E beddown/optempo**
- **Overview of F-15E parts data**
- **Underlying factors and assumptions**
- **Demonstration**
 - Process
 - Results



F-15E Beddown/Optempo

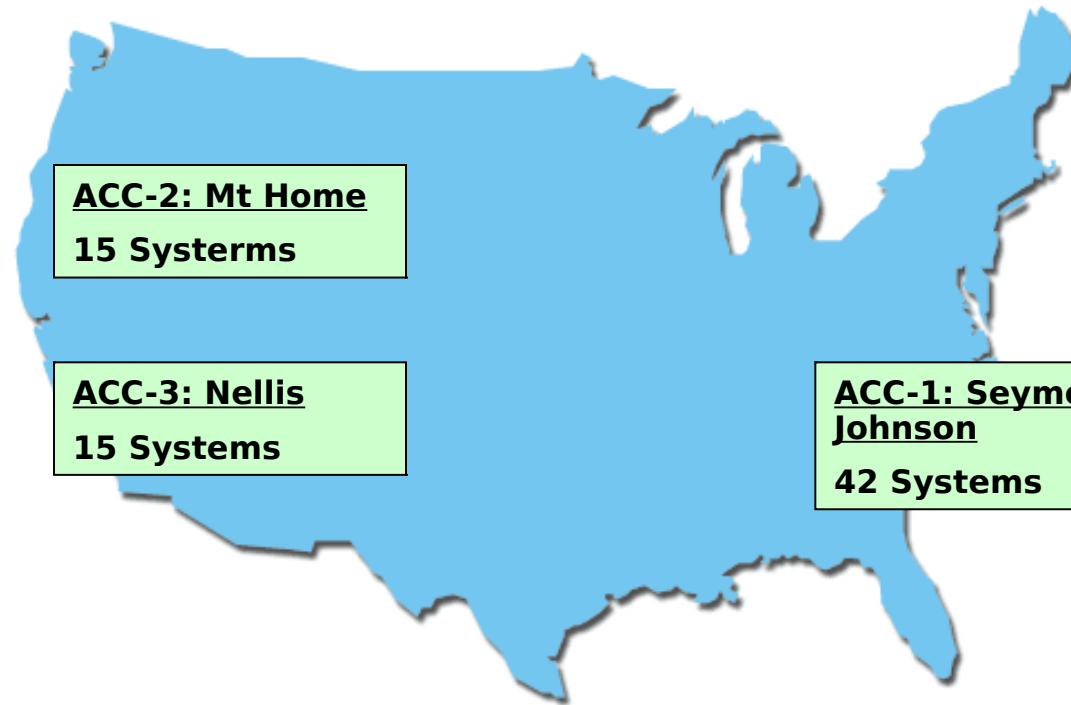


D-1
24 Systems

PACAF:
Elmendorf
18 Systems

"Commands"	Name	Aircraft	Sites	Hours Per Month Per AC	Total Hours Per Month
1	"Deployed"	48	2	25.8	1238.4
2	ACC	72	3	25.8	1857.6
3	USAFE	48	1	31.5	1512.0
4	PACAF	18	1	27.5	495.0
	Totals	186	7	27.4	5103.0

D-2
24 Systems



ACC-2: Mt Home
15 Systems

ACC-3: Nellis
15 Systems

ACC-1: Seymour Johnson
42 Systems

USAFE:
Lakenheath
24 Systems



Overview of F-15E Parts Data



Indenture	NSNs		
	Consumables	Reparables	Totals
1	1507	432	1939
2	161	702	863
3	23	56	79
4	0	4	4
Totals	1691	1194	2885



Underlying Factors and Assumptions



- **Air Force provided reliability factors and cycle times**
- **Maintenance capacity is equal to requirement with 30% surge capability**
- **Baseline case**
 - Depot repair funding equals requirement
 - No workarounds for baseline assessment:
 - No cannibalizations
 - No expedited shipments
 - No lateral supply
- **Full funding of warfighter programs**
- **Weapon system availability target: 85%**



Demonstration Process



- **Baseline**
- **Case 1 - Improved reliability**
- **Case 2 - Improved depot repair cycle time**
- **Case 3 - Improved reliability and depot repair cycle time**
- **Case 4 - Sparing Implications of the above Improvements**
- **Case 5 & 6 - Effects of Workarounds**
- **Case 7 - Depot Overhaul of Ground Systems**
- **Cases 8 - Depot Overhaul of Life-limited Components**
- **Case 9 - Depot Overhaul of Aircraft**



Baseline Assessment vs Reliability Improvement



Capability Alternatives	Description	Weapon System Availability Achieved	Annual "Costs"					Seven Year Present Value Savings (4% discount rate) Without Implementation Costs and Transportation (\$M)	Implementation costs (\$M)
			Spares Levels (\$M)	Repair (\$M)	Procurement (\$M)	Total (\$M)	Ton-miles (K)		
Baseline Run	Baseline Run: Sets Levels Using AF Process	71.3%	\$1,318	\$483.3	\$154.0	\$637.3	8546	-	None
Case 1 - Improved Reliability	Top 10 Reliability Improved 50%	73.3%	\$1,318	\$481.5	\$143.3	\$624.8	8369	\$78.0	X

- **Baseline spares levels of 1.3B was developed using the ASM model that is consistent with Air Force sparing methods**
- **Improved by 50% the reliability of the top 10 LRUs that accounted for a little more than 20 percent of the daily LRU failures**
- **This improved readiness by 2 percentage points (almost 4 F-15Es)**
- **These LRUs were relatively cheap (8 of 10 were less than \$1000) with small repair costs and relatively large condemnation rate**
 - \$1.8M annual repair saving
 - \$10.7M annual procurement saving



Baseline Assessment vs Reliability Improvement with Reliability Evaluator



Capability Alternatives	Description	Weapon System Availability Achieved	Annual "Costs"					Seven Year Present Value Savings (4% discount rate) Without Implementation Costs and Transportation (\$M)	Implementation costs (\$M)
			Spares Levels (\$M)	Repair (\$M)	Procurement (\$M)	Total (\$M)	Ton-miles (K)		
Baseline Run	Baseline Run: Sets Levels Using AF Process	71.3%	\$1,318	\$483.3	\$154.0	\$637.3	8546	-	None
Case 1 - Improved Reliability	Top 10 Reliability Improved 50%	73.3%	\$1,318	\$481.5	\$143.3	\$624.8	8369	\$78.0	X
Case 1A - Improved Reliability from Reliability Evaluator	Top 10 Reliability Improvement using the Reliability Evaluator	73.7%	\$1,324	\$483.3	\$151	\$633.9	8459	\$15.6	\$51.5

- **Case 1A is the results of having the reliability evaluator determine which components should have their reliability improved to achieve a specified goal for the lowest cost**
- **Implementation cost were determined to be \$51.5M**
- **The System Evaluator assessed the effects of these reliability improvements:**
 - Readiness improved to 76.4 percent (larger than the 73.3% of Case 1)
 - However, the seven year present value cost saving were less (\$54.9M vs \$78.0M)



Baseline Assessment vs Depot Repair Cycle Improvement



Capability Alternatives	Description	Weapon System Availability Achieved	Annual "Costs"					Seven Year Present Value Savings (4% discount rate) Without Implementation Costs and Transportation (\$M)	Implementation costs (\$M)
			Spares Levels (\$M)	Repair (\$M)	Procurement (\$M)	Total (\$M)	Ton-miles (K)		
Baseline Run	Baseline Run: Sets Levels Using AF Process	71.3%	\$1,318	\$483.3	\$154.0	\$637.3	8546	-	None
Case 2 - Improved Cycle Time	Top 20 Depot Cycle Time: 3x Improvement for Cycle time; 1.5x Improvement for Manpower Costs	74.3%	\$1,318	\$415	\$154	\$568.8	8545	\$427.6	X

- **Selected top 20 reparable items that accounted for almost 65% of the annual depot repair costs**
- **Reduced their depot repair cycle time by a factor of 3**
- **Reduced depot repair cost by 25%**
- **This improved readiness by 3 percentage points (almost 6 F-15E)**
- **WSSVSM does not address the implementation costs of reduced cycle times**
- **The seven year present value savings for repair is \$427.6M**



Baseline Assessment vs both Reliability and Depot Repair Cycle Improvement



Capability Alternatives	Description	Weapon System Availability Achieved	Annual "Costs"					Seven Year Present Value Savings (4% discount rate) Without Implementation Costs and Transportation (\$M)	Implementation costs (\$M)
			Spares Levels (\$M)	Repair (\$M)	Procurement (\$M)	Total (\$M)	Ton-miles (K)		
Baseline Run	Baseline Run: Sets Levels Using AF Process	71.3%	\$1,318	\$483.3	\$154.0	\$637.3	8546	-	None
Case 1 - Improved Reliability	Top 10 Reliability Improved 50%	73.3%	\$1,318	\$481.5	\$143.3	\$624.8	8369	\$78.0	X
Case 2 - Improved Cycle Time	Top 20 Depot Cycle Time: 3x Improvement for Cycle time; 1.5x Improvement for Manpower Costs	74.3%	\$1,318	\$415	\$154	\$568.8	8545	\$427.6	X
Case 3 - Improved Reliability & Cycle Time	Both Top 10 and Top 20	76.8%	\$1,318	\$412	\$143	\$555.0	8372	\$513.7	X

- **Case 3 combines the affects of Case 1 and Case 2**



The Sparing Implications of Improvements



Capability Alternatives	Description	Weapon System Availability Achieved	Annual "Costs"					Seven Year Present Value Savings (4% discount rate) Without Implementation Costs and Transportation (\$M)	Implementation costs (\$M)
			Spares Levels (\$M)	Repair (\$M)	Procurement (\$M)	Total (\$M)	Ton-miles (K)		
Baseline Run	Baseline Run: Sets Levels Using AF Process	71.3%	\$1,318	\$483.3	\$154.0	\$637.3	8546	-	None
Case 1 - Improved Reliability	Top 10 Reliability Improved 50%	73.3%	\$1,318	\$481.5	\$143.3	\$624.8	8369	\$78.0	X
Case 2 - Improved Cycle Time	Top 20 Depot Cycle Time: 3x Improvement for Cycle time; 1.5x Improvement for Manpower Costs	74.3%	\$1,318	\$415	\$154	\$568.8	8545	\$427.6	X
Case 3 - Improved Reliability & Cycle Time	Both Top 10 and Top 20	76.8%	\$1,318	\$412	\$143	\$555.0	8372	\$513.7	X
Case 4 - Case 3 with Optimum Spares to Achieve Baseline Capability	Both Top 10 and Top 20 with Optimum Spares to achieve Baseline Availability	72.7%	\$1,124	\$412	\$143	\$555.0	8370	\$707.7	X

- **Case 4 shows the potential spares saving of \$192M if the baseline readiness of 71.3% is acceptable**
- **Optimum sparing was applied to data base that improved reliability (Case 1) and improved repair cycle time (Case 2)**
- **The readiness achieved with optimum sparing for this case was 72.7% (slightly larger than the baseline of 71.3%)**



Effects of Workarounds



Capability Alternatives	Description	Weapon System Availability	Spares Levels (\$M)	Repair (\$M)	Procurement (\$M)	Total (\$M)	Seven Year Present Value Savings (4% discount rate) Without Implementation Costs and Transportation (\$M)	Implementation Costs
Case 5 - Baseline Run with Workarounds	Baseline Run: Sets Levels Using AE Process	85.7%	\$1,318	\$483.3	\$154.0	\$637.3	-	-
Case 6 - Case 4 With Workarounds	Both Top 10 and Top 20 with Optimum Spares to achieve Baseline Availability	85.7%	\$1,124	\$412	\$143	\$555.0	\$707.7	X

Capability Alternatives	Description	Annual Ton-miles (K)			CANNs per 100 hours
		Standard	Expedited	Lateral Supply	
Case 5 - Baseline with Workarounds	Baseline Run with Lateral Supply, Expedited shipments and Cannibalization	8274	245	128	2.5
Case 6 - Case 4 With Workarounds	Both Top 10 and Top 20 with Optimum Spares to achieve Baseline Availability	8078	256	150	2.1

- These table present the results when “workarounds” (expedited shipments, lateral supply and cannibalization) are employed for the Baseline and Case 4
- Readiness in both cases increases to 85.7% but Case 6 obtains this improvement with \$707M savings less implementation costs



Summary of Depot Overhaul Funding

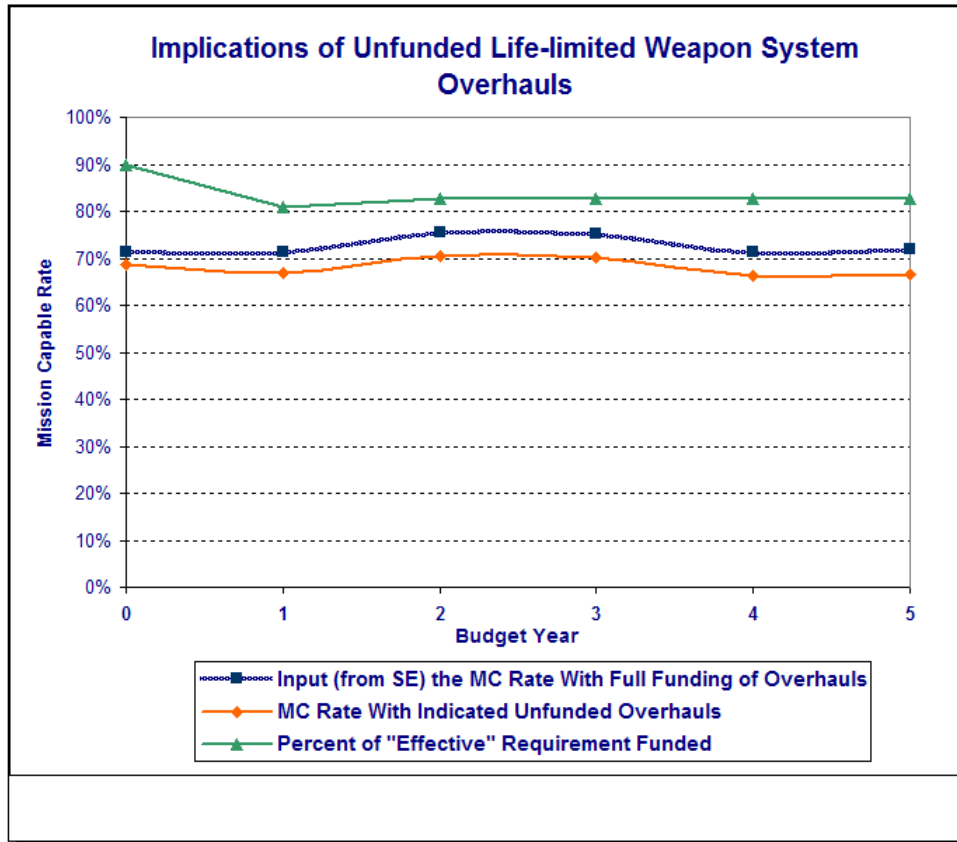


Capability Alternatives	Description	Weapon System Availability Achieved	Annual "Costs"				Ton-miles (K)	Seven Year Present Value Savings (4% discount rate) Without Implementation Costs and Transportation (\$M)
			Spares Levels (\$M)	Repair (\$M)	Procurement (\$M)	Total (\$M)		
Case 7 - Improved depot Overhaul funding for ground Systems	Improve unfunded Depot Maintenance Overhauls of Ground Systems Reduced from 2 to 0	76.1%	\$1,318	\$476	\$154	\$629.6	8433	\$48.1
Case 8 - Unfunded Component Overhauls	Unfunded Depot Maintenance Overhauls of Components - 90% funded in first year	70.1%	\$1,318	\$483	\$154	\$636.7	8545	\$3.7

- In Case 7 demonstrates the capability of the WSSVSM to capture the readiness implications of fully funding ground system overhauls.**
 - Readiness improves to 76.1% when 20% of the active inventory that should have been overhaul is overhauled
 - Costs of additional overhaul is not shown
- Case 8 demonstrates the capability to model the readiness implications if depot overhaul funding for components is reduced by 10% in the first year of a multi-year program**
 - Small reduction in depot maintenance funding reduces average readiness from 71.3% to 70.1%



Readiness Implications of Unfunded Aircraft Overhauls



Case 9 postulates information about the aircraft overhaul program requirements and funding.

If aircraft overhaul program is funded at 90% for the first two years, it is estimated that mission capable rates would be reduced 2-3 percentage points.

	BY	BY+1	BY+2	BY+3	BY+4	BY+5
Baseline Requirement (\$M)	\$110	\$100	\$105	\$110	\$115	\$120
Funded Program	\$99	\$90	\$105	\$110	\$115	\$120
Percent of "Effective" Requirement Funded	90.0%	81.0%	82.6%	82.6%	82.6%	82.6%
MC Rate With Unfunded	68.6%	67.0%	70.6%	70.2%	66.2%	66.7%



Next Steps



- **Demonstrate WSSVSM Capability using M1 Tank data**
- **Establish overall game plan for functional development and deployment**
- **Develop simplified user interface that facilitates modeling process**
- **Demonstrate functional capability to services**
 - Identify deployment possibilities
 - Quantify data availability
 - Receive feedback and suggestions from potential user community
- **Develop detailed roadmap/define and schedule introduction of functional capabilities**
- **Integrate forthcoming release of RE (SyOp Pro-Opta)**

